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Do rural and urban multipliers differ?

see page 1

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In This Issue

Doing research is sometimes like sailing in a small boat. There are times when you know exactly where you want to go and the winds are favorable. You can set a course directly toward the destination and make good speed. With deductive logic, as with running a course downwind, you proceed directly and unerringly from a known origin to a known destination. There are other times when you are not sure either of your destination or of the way the winds have shifted. You turn the rudder and trim the sails until it feels about right. If your target is upwind, you find yourself on an oblique course. With inductive logic, as with beating a course upwind, you proceed tentatively, first on one tack, then on another, never steering a course directly toward your destination. Your general progress is probably in the right direction, but when the winds shift you may find yourself with sails luffing in the wind, pointed in the general direction of truth, but standing still.

The articles in this issue sail uncharted courses toward useful destinations. Sometimes they find themselves with sails shaking in the wind. For example, the tests of statistical significance are weak. Yet each article relies on economic theory to proceed on course.

The authors of the first article seek to explain, using monetary as well as real variables, regional variations in rural and urban growth. The preliminary version of the econometric model reported here is not well calibrated; simulated time paths of certain key variables in one of the regions are obliquely related to actual time paths. Yet the results appear reasonable: tight monetary conditions retard real growth, and national monetary policy affects rural areas differently than urban ones.

The authors of the second article seek to explain, using both biological and economic logic, the effect on pesticide demand of increasing resistance. Only two of six parameters estimated were statistically significant. Yet the results appear reasonable: through a specified range, farmers are willing to purchase larger quantities of pesticides at a given price as resistance increases.

Clark Edwards

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Rural Impacts of Monetary Policy

By Chase Econometric Associates, Inc., and the Economic Research Service*

Abstract

A multiregional econometric model evaluates the impacts of changes in monetary policy on economic development in metropolitan and nonmetropolitan parts of each of the four principal U.S. Census regions. Regional variations in the adaptation to a change in national monetary policy depend on a specific region's economic structure. Nonmetro regions are generally less affected by overall changes in monetary policy than are metro regions. Increases in credit to nonmetro regions increase nonmetro economic activity. But, the accompanying decrease in metro activity—caused by decreased credit availability—more than offsets the nonmetro gains, and these nonmetro gains tend to dissipate over time.

Keywords

Monetary policy, rural-urban comparisons, regional development, economic theory

The historical migration of people into metropolitan (metro) regions was reversed during the seventies. The rate of economic growth, as measured by changes in income and employment, is now greater in nonmetro than in metro regions. The Federal Government has considerable interest in the economic development of nonmetro regions. To better understand the process of regional and subregional economic growth, one needs to examine the relationships between real variables and monetary variables. While some markets affecting regional growth are national, others are primarily regional. Market structure differs between metro and nonmetro regions.

USDA has a multibillion dollar set of loan and grants programs for rural development pursuits such as housing, community facilities, and business and industrial activities. To evaluate lending programs and policies for rural areas over the long run, we need a better understanding of the institutional and economic relationships between Federal Reserve policy, Treasury deposits, and private commercial balances and their transfer and of how these relationships affect commercial banks in both metro and nonmetro regions.

Economists have generally explained regional economic growth in real terms and have ignored the monetary aspects of the regional growth process. Most income-expenditure models of growth are national, and the models are designed to examine closed economic systems. These closed, single-region models are inappropriate for analyzing regional growth for several reasons: they do not account for relative price differentials and changes between regions; they fail to explain interregional flows of products, capital, labor, money, and information; they ignore determinants of regional inflation rates; and they omit observation of the determinants of interest rate differentials, capital market segmentation, and institutional and behavioral differences. No simple model can be constructed that will expose all aspects of regional financial markets. However, we must and can delineate a regional structure which will help us understand the flow of credit and capital among regions, the interactions among real financial activities, and the differential effects of national monetary policy on regional growth.

Scope

This article describes a project carried out by Chase Econometrics, under contract to ERS, to develop an analytical model capable of assessing the similarities and differences

*Many people have contributed to this project. At Chase Econometrics, overall guidance for the project was provided by Lawrence Horwitz, vice president, regional economics; Robert Shriner, director of Washington operations; and Kevin Hurley, director of financial analysis. Bradley Perry served as project manager during much of the project; he was succeeded by John Hagens, who completed the development of the model and carried out the policy simulations. Data collection and equation estimation were done by Alison Baldock and others in the regional economics department, who also helped prepare the final report. At the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA), Clark Edwards, Richard French, Fred Hines, James Mikesell, Daniel Milkove, and David Weisblat provided recommendations and assistance. This article is based on Staff Report AGES 810825, *Regional Financial and Monetary Policy Analysis Model*, under RMA Contract No. 53-319S-9-02692, Sept. 1981.

in the effects of monetary and other national policies on different U.S. regions and on their metro and nonmetro areas. The model synthesizes regional and monetary models evolved in the late seventies by Chase Econometrics and others with the policy analysis requirements of USDA and others concerned with the effects of Government policies on regional and urban-rural differences.

The model presented here divides each of the four major U.S. Census regions—North Central, Northeast, South, and West—into metro and nonmetro subregions. We used the April 1973 metro area definition. Each of the eight regions has a financial sector linked to a nonfinancial sector. There are linkages among the regions as well as linkages to national financial markets and to aggregate demand. To capture these relationships, the model uses 164 statistical equations, plus 114 identities from which various accounting relationships are calculated at the regional and national levels. There are 38 exogenous variables. The eight regions used to demonstrate the model represent a compromise; they are diverse enough to validate the concept without the great computational complexity that additional regions would have introduced. A national sector explains variables, such as consumer demand and prices, that are not amenable to geographic disaggregation.

Because deregulation of financial institutions began to occur after the project was nearly half completed, the model does not incorporate this deregulation and the resulting changes in financial infrastructure.

Model Design

The model is structured in four blocks:

- A national financial market,
- Eight regional financial markets,
- A national real economy, and
- Eight regional real economies.

Figure 1 shows how the four blocks fit together. It reveals substantial simultaneity within and among the blocks. We present an overview of how the model evaluates the effect of tightening monetary policy as an example of its capabilities. The numbers in our description refer to the numbered relationships in figure 1. Further details are available in the project report.

The first impact of tightening monetary policy occurs in the national financial markets: (1) interest rates rise. Rising national interest rates have two effects: (2) the investment component of national aggregate demand contracts, and (3) changes occur in regional deposits; demand, savings, and thrift deposits contract and time deposits expand. Each of the eight regions responds differently, depending on local market structure. As national aggregate demand contracts, (4) national industrial production drops, thereby (5) reducing manufacturing employment.

Manufacturing is regarded as a basic industry whose aggregate level is determined by national financial and real conditions. This model considers manufacturing investment as the key to a region's growth or decline. Over the long run, firms maximize profits by investing in those regions where the anticipated costs of production (including labor costs, energy costs, and tax costs) are relatively low. In the shorter run, however, manufacturing activity within a region is determined primarily by the national demand for the products produced in that region.

Variations in regional credit conditions influence the geographic pattern of manufacturing activity. First, even if credit conditions vary little across regions, those regions with relatively credit-sensitive industries suffer more when credit markets tighten. Second, when credit conditions do vary across regions, they produce differential effects. Regional impacts of the change in manufacturing depend both on regional variations in the share of the industry and on financial and real conditions at the regional level, which affect the multipliers for local industries such as construction and services.

The decline in bank deposits in each region causes (6) a drop in the funds available for local mortgages, thus lowering housing starts. Similarly, (7) the changing loan to deposit ratios at regional banks cause (8) the decline in manufacturing employment to spread differentially across regions. The declines in regional housing starts (9) reduce construction employment regionally. Changing regional financial conditions affect (10) commercial construction employment. As employment declines (11) regional personal income declines, reducing other locally oriented employment, which simultaneously leads to (12) further declines in personal income. The decline in regional personal income causes (13) a further drop in national aggregate demand, (14) in regional housing demand, and (15) in regional deposits, with subsequent effects filtering through all the components of the model. It is clear that there are several channels through which monetary policy can affect each region.

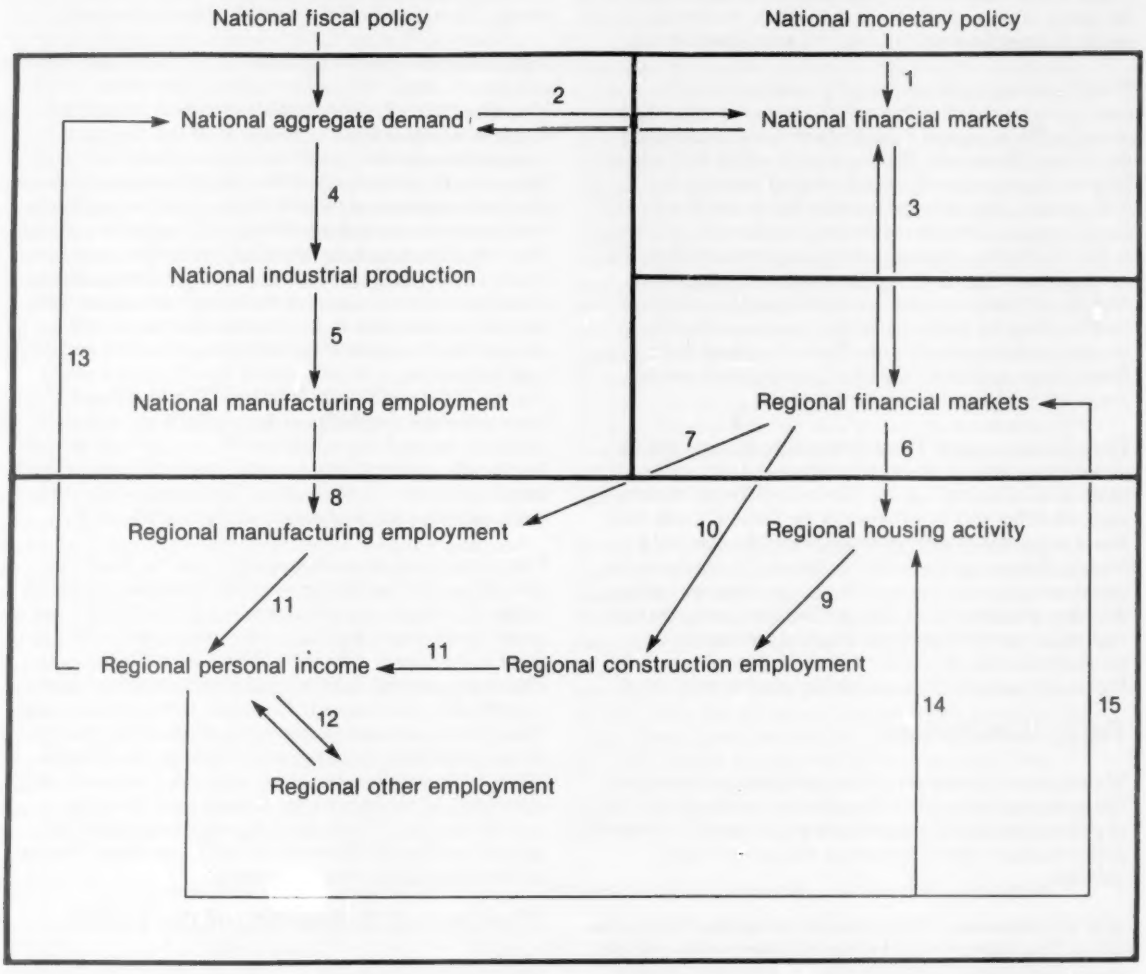
Monetary Policy

In developing its monetary policy, the Federal Reserve seeks to attain the goals of full employment, stable prices, balance in international payments, and economic growth. Each goal is important, but at any time, one or another may have greater influence because it deviates more from acceptable levels.

All these goals are national. The Federal Reserve does not intentionally follow a policy aimed at influencing any particular region. This does not mean that the results of

Figure 1

The Major Relationships Among the Sectors of the Model



Federal Reserve policy do not differ from region to region. Rather, it means that such effects are unintentional.

Prior to October 1979—the period analyzed in this study—the Federal Reserve employed a two-stage implementation procedure. First, it used an intermediate target variable, the money stock, to indicate performance. Second, it used a short-term operating variable to alter its stance between expansiveness and restrictiveness as measured by the Federal funds rate. The operating variable is the supply of bank reserves relative to the demand. Bank reserves are the deposits commercial banks hold at Federal Reserve banks plus vault cash. Banks must hold reserves to meet reserve requirements, and, therefore, they demand reserves for this purpose. By buying and selling Government securities in the open market, the Federal Reserve can increase or decrease the supply of reserves and change the Federal funds rate.

Banks actively trade reserves among one another. For these transactions, reserves are called Federal funds. The price of borrowing Federal funds is the Federal funds

rate. This rate naturally reflects the interaction of the demand for and the supply of reserves so that the Federal Reserve's open market operations are mirrored by changes in the funds rate. An expansive policy increases the supply of reserves and lowers the rate. A restrictive action reduces the supply of reserves and raises the rate.

The effect of monetary policy on the real sector of the economy is transmitted through the cost and availability of credit. The sequence of events begins with a change in the Federal funds rate. The markets in which the Federal Reserve operates have highly developed interregional linkages and, for our purposes, may be treated as a national market. Coordinated through brokers and dealers in New York City, transactions in Government securities and in Federal funds are made nationwide. Large borrowers and lenders in money centers make transactions directly. Smaller participants in more remote locations use correspondent banks and offices of national brokerage firms. Daily quotations for these financial instruments appear in newspapers nationwide.

The subsequent portfolio adjustments to the availability of reserves and to the Federal funds rate, however, are likely to vary among regions. Banks in different regions respond differently to a change in the Federal funds rate, based on the availability of deposits and the demand for loans in their respective regions. Hence, the impact of national monetary policies on regional spending and saving decisions will depend on regional financial practices and regional economic conditions. Regional variations in credit availability are reflected in loan deposit ratios: the higher the ratio, the less availability of additional credit.

Policy Simulations

We simulated three alternative monetary policies using the econometric model. Although we discuss only this set of policies, the model is capable of analyzing other types of policy changes—fiscal policies as well as monetary policies.

A brief discussion of the methods of policy simulation is in order. There are two types of simulations: within-sample and out-of-sample. Within-sample simulations produce timepaths of the endogenous variables (explained by the model) for the time period over which the model was estimated. If the actual values of the variables exogenous to the model are used for the within-sample simulation, then comparing the simulated and the actual values of the endogenous variables is one means of evaluating the reliability of the model. This particular simulation is referred to below as the baseline. An out-of-sample simulation reproduces timepaths of the endogenous variables over a time period not used in the estimation of the model, typically a forecast. This type of simulation requires a forecast of all the model's exogenous variables. It also requires an assumption of no structural change. Simulations discussed in this section are all within-sample. We did not produce out-of-sample simulations because the recent change in banking regulations almost certainly will change the structure of the regional financial equations.

A clear statement of the policy questions is key to using an econometric model for policy analysis. How much and in what direction will a given policy change affect a set of variables explained by the model? Note that the answer requires two simulations. First, we run a baseline simulation, using the historical values of the policy variable (and all other exogenous variables). Second, we run an alternative simulation using the new values of the policy variable (the new value equals the historical value plus the policy change), while holding the exogenous variables at their historical values. Comparing the second simulation with the baseline produces the estimated effect of the policy change. Multiequation econometric models are normally used to produce point estimates of the effects of a policy change. If the coefficients in the model are unbiased, then these estimates are unbiased. In principle, the models could also be used to produce confidence interval estimates for the policy effects. This is costly, however, especially for large models, and is rarely done. We have produced only point estimates for the simulations presented below.

Using our model, we addressed two specific policy questions. First, for the 14 quarters from the third quarter of 1974 (1974:3) to the fourth quarter of 1977 (1977:4)—the latest period over which data were available for all variables in the model—what would have been the regional effects of a general tightening of monetary policy? More specifically, would some U.S. regions have suffered more than others, and would nonmetro regions suffer relatively more or less than metro regions? There are two simulations of this question: one of a temporary change and the other of a permanent change. Second, over the same period, what would have been the regional effects of a general expansion of nonmetro credit, assuming the overall monetary policy was unchanged?

The Overall Reliability of the Model

The validity of the policy simulations depends on the overall reliability of the model. Figures 2 and 3 plot the baseline values relative to the historical values for two key variables—personal income and total employment—for each region. In the simulations discussed below, we use the historical values of the Federal funds rate to produce the baseline. We use this procedure in this validation exercise as well.

The model underpredicts the trend of economic activity for the United States as a whole, although the model overpredicts the trends in the metro South. (U.S. and Census region totals are not shown in the accompanying tables

and figures but are occasionally discussed in the text.) These figures demonstrate that the model is not fully calibrated. Even so, the current version of the model stays within a reasonable percentage for most of the trends; the largest prediction errors occur in the metro West where our calibration problems are the greatest (see fig. 2 and 3).

An assessment of the goodness-of-fit of the model is subjective. A comparison with a similar model would be helpful but, in this case, no other regional financial models are easily comparable. We believe the overall fit of this model is good enough to justify using it to analyze policy alternatives relative to the baseline of the model such as those later discussed. However, results of alternative policy simulations can be further refined. What follows is a beginning, not a conclusion. Even so, the insights into rural and regional impacts of national policy appear to be sufficiently robust to warrant sharing them with others.

The Regional Effects of a Tightening of Monetary Policy

The key indicator of monetary policy in the model is the Federal funds rate, an endogenous variable. There are several ways we could implement a tightening of policy. We could change the coefficients on the variables assumed to be the targets for the Federal Reserve. For example, if we increase the coefficient on the inflation variable, the rise in inflation over the simulation period would lead to a higher Federal funds rate. Alternatively, we could increase the constant term of the Federal funds equation and allow the Federal Reserve reaction coefficients to remain constant. This procedure, however, would build in contradicting behavioral assumptions; the constant-term increase in the funds rate would increase unemployment and, thus, lead to an offsetting decrease in the funds rate (the coefficient on unemployment in the funds rate equation is negative). We could have set either total U.S. demand deposits or the Federal funds rate exogenously, depending on which of the two is taken as the target for monetary policy. We chose to make the Federal funds rate exogenous.

The baseline used the historical values of the funds rate, whereas the alternative simulation added exogenously to the historical values of the funds rate. Two tight money simulations were tried—a temporary and permanent one. The temporary policy increases the funds rate by 1 percentage point only in 1974:4 and it returns to historical levels thereafter. The permanent policy increases it by 1 percentage point above the historical level in each quarter starting in 1974:4. These effects of the alternative simulations are expressed as a percentage of the baseline simulation. Table 1 presents the effects on six key variables of the permanent tight monetary policy as of 1977:4. The six variables are: personal income, total employment, manufacturing employment, housing starts, total deposits, and the commercial loan-to-deposit ratio. We discuss results of the temporary policy, but they are not shown in the table. The direction was the same for both policies, and the magnitude of change was small relative to the permanent policy.

As expected, the model estimates that the tightening of monetary policy leads to a decline in national real personal income. By 1977:4, 14 quarters after the increase in the Federal funds rate, national income is 3.5 percent below baseline when the tightening is permanent. When the interest rate increase is temporary, income falls by only 0.5 percent by 1977:4. The slight adverse effect in the first quarter of the temporary simulation slowly accumulates so that the economy gradually falls further below the baseline, even though monetary policy was restored in the second quarter to its baseline level. For the permanent tightening case, U.S. metro income declines by 3.7 percent by 1977:4, or slightly more than the nonmetro decline of

Table 1—Tight monetary policy: Simulated levels of six variables, in the fourteenth quarter of the simulation (1977:4)

Economic variable	North Central		Northeast		South		West	
	Metro	Nonmetro	Metro	Nonmetro	Metro	Nonmetro	Metro	Nonmetro
	Percent of baseline							
Real personal income	96.4	100.1	96.8	95.9	98.4	95.3	91.5	95.3
Total employment	98.1	99.6	98.1	96.7	98.9	98.3	91.8	97.9
Manufacturing employment	96.2	96.2	96.4	96.5	96.4	97.6	77.9	96.6
Housing starts	76.0	98.6	70.8	74.5	93.4	85.3	481.7	100.6
Total deposits	94.2	97.9	94.9	86.4	95.2	94.3	83.8	94.2
Commercial loan/ deposit ratio	102.2	98.9	102.5	100.8	100.8	100.2	118.0	101.4

Figure 2

Real Personal Income by Region, Baseline Simulation

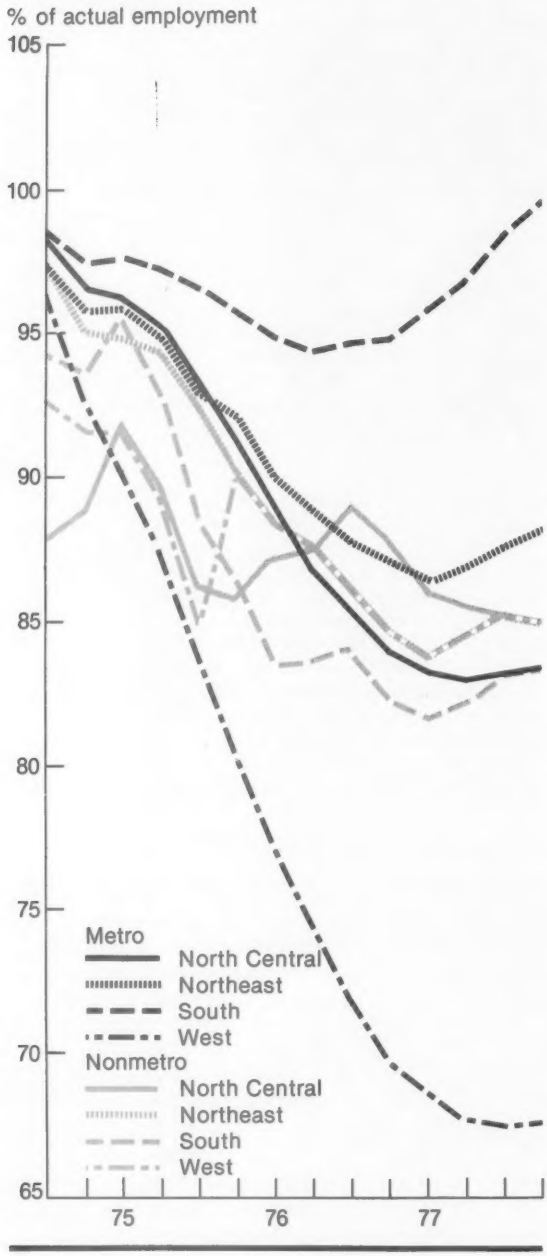
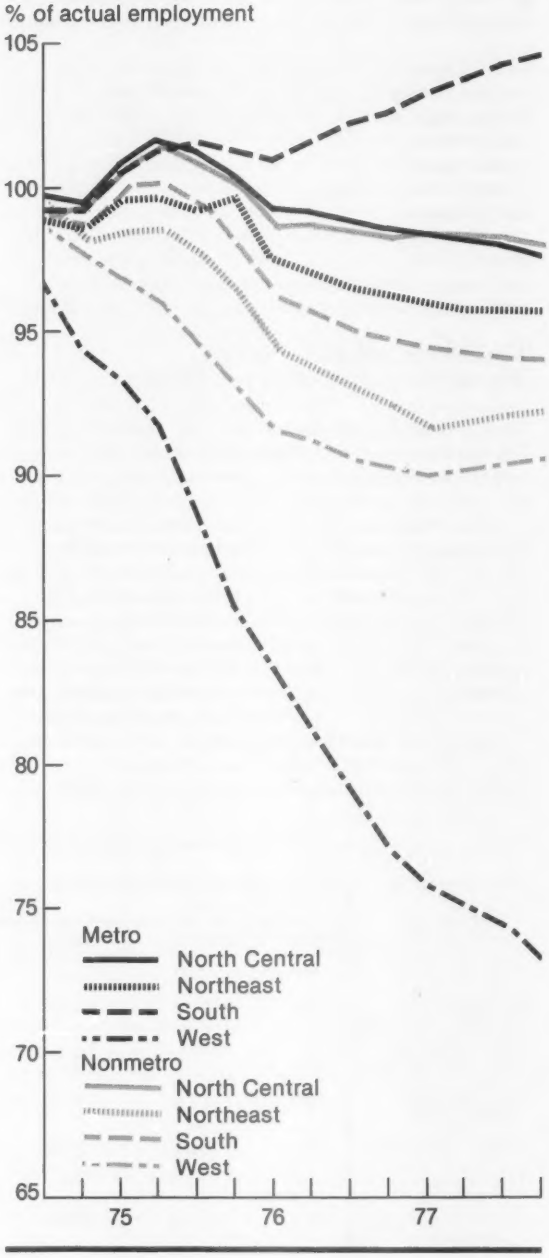


Figure 3

Employment by Region, Baseline Simulation



3.2 percent, largely because of a severe contraction simulated for the metro West.

Income and employment changes by region in response to a permanent tightening of monetary policy are shown in figures 4 and 5; the 1974:4 levels appear in table 1. The metro West was most adversely affected, possibly a reflection of poor calibration of the model. The nonmetro North Central region was least affected. Among the other six regions, the nonmetro areas tended to contract more than the metro areas in income and employment.

The decline in personal income nationally is caused by the fall in employment. By 1977:4, for the permanently tight monetary policy, employment nationally is 2.4 percent below baseline, and manufacturing employment is 4.6 percent below baseline. Although manufacturing employment declines by 5.5 percent nationally in metro areas, heavily weighted by a simulated severe contraction in the metro West, it falls by only 3.0 percent in nonmetro regions. The regional declines in manufacturing employment are more severe than the declines in total employment. Manufacturing employment was particularly hard hit in the metro West, according to simulation results in table 1. The equation explaining manufacturing employment in the metro West involves elastic respones to changes in regional credit, whereas the regressions for the other seven regions indicate inelastic responses.

Housing starts in different regions are primarily determined by real personal income and by the change in the stock of real mortgages, both in the region and the adjoining region. In turn, mortgages were determined by the stocks of deposits in commercial banks and thrift institutions. A rise in the Federal funds rate results in a decline in the stock of total deposits, the sum of demand, time, savings, and thrift deposits. When monetary policy is permanently tightened, total national deposits decline by 6.6 percent below baseline by 1977:4. This decline in deposits, which is not offset by an equally large decline in the price level (the GNP deflator is 1.6 percent below baseline by 1977:4), leads to a decline in real mortgages and a corresponding decline in housing starts. National housing starts declined by more than 20 percent by 1974:4.

Before discussing the effect on housing starts across regions, we briefly review the effect of monetary policy on housing in the model. Refer to figure 1. The first-round decline in regional housing, caused by the drop in local deposits and mortgages as the national funds rate is raised, generates feedback effects. Regional construction employment declines, reducing personal income. The decline in local personal income further reduces demand for housing. It also reduces the flow of savings into deposits, which causes a further contraction in mortgages and, therefore, housing starts. The housing start equations were not completely satisfying. Hence, the regional pattern that emerges must be viewed cautiously.

Metro housing starts decline by 30 percent, while nonmetro starts decline by less than 10 percent by 1977:4. The equations for housing starts in the metro West produce bizarre results. Both the baseline and alternative simulations produce negative values for housing starts over the forecast period. The values become negative in 1975:1 for the alternatives and become negative in 1975:2 for the baseline. In consequence, the ratios switch from positive to negative to positive in the first four quarters of the simulation comparisons, and they rise to dubious heights by the final quarter. The three regions in which housing starts were most adversely affected by the tight monetary policy were the metro Northeast, nonmetro Northeast, and metro North Central.

Table 1 presents the effects of the monetary tightening on the total deposits and on the loan-deposit ratios. Subnational loan-deposit ratios are a proxy for regional credit conditions in the model. When monetary policy is tight, deposits are reduced relative to loans and the loan-deposit ratio rises. The loan-deposit ratio is a regional indicator of the tightness of money. For the permanently tight money policy, the national loan-deposit ratio is 4.8 percent above baseline by 1977:4. The ratio in nonmetro regions peaks at 1.0 percent above baseline in 1976 and falls to only 0.5 percent above baseline by 1977:4. This indicates that nonmetro credit conditions are affected only slightly by a general tightening of monetary policy. The metro loan-deposit ratio rises smoothly to 6.7 percent above baseline by 1977:4, indicating that a general credit tightening mostly falls on metro regions. The loan-deposit ratio rose most in the metro West. The very high level reached there may indicate that further calibration of the model is needed. However, metro regions consistently show tighter monetary conditions than nonmetro regions, according to the loan-deposit ratio indicator for each of the four Census regions. The nonmetro North Central region, which displayed the least adverse effects on income and employment, did not experience a credit squeeze in response to the national policy.

The Regional Effects of a Credit Shift

The second type of experiment we performed was to shift credit from metro to nonmetro regions. We made several assumptions. First, the increased credit to nonmetro regions is initially distributed across nonmetro demand deposits. Each of the four nonmetro regions received the same percentage increase in demand deposits in 1974:4. Second, the increased credit to nonmetro regions was not financed with expansionary monetary policy. Hence, we hold the Federal funds rate in this experiment

Figure 4

Real Personal Income by Region, Permanent Tightening of Monetary Policy

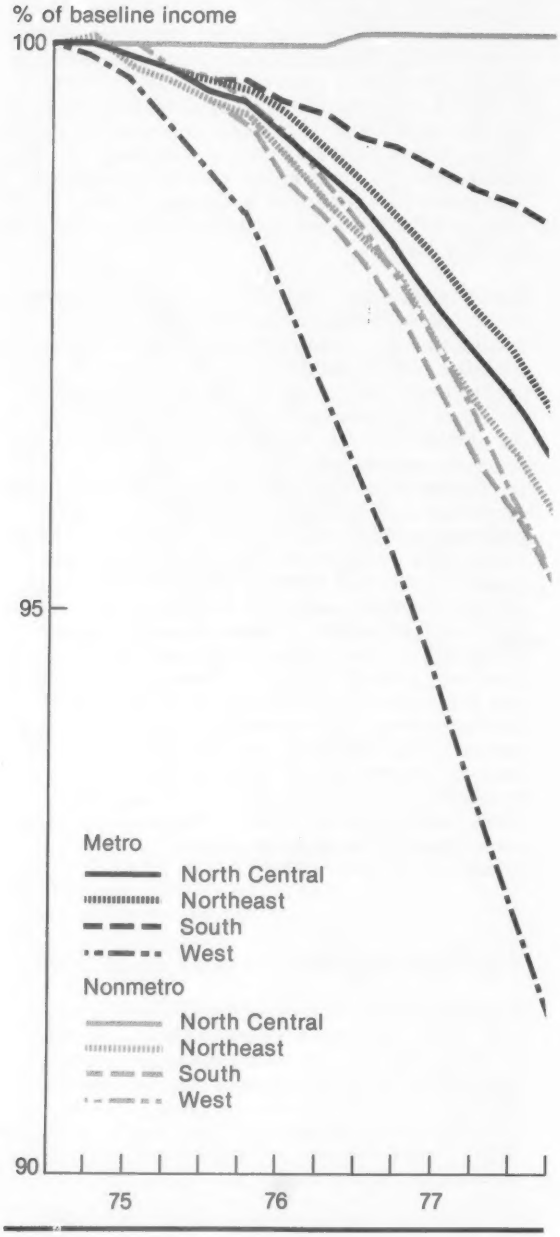
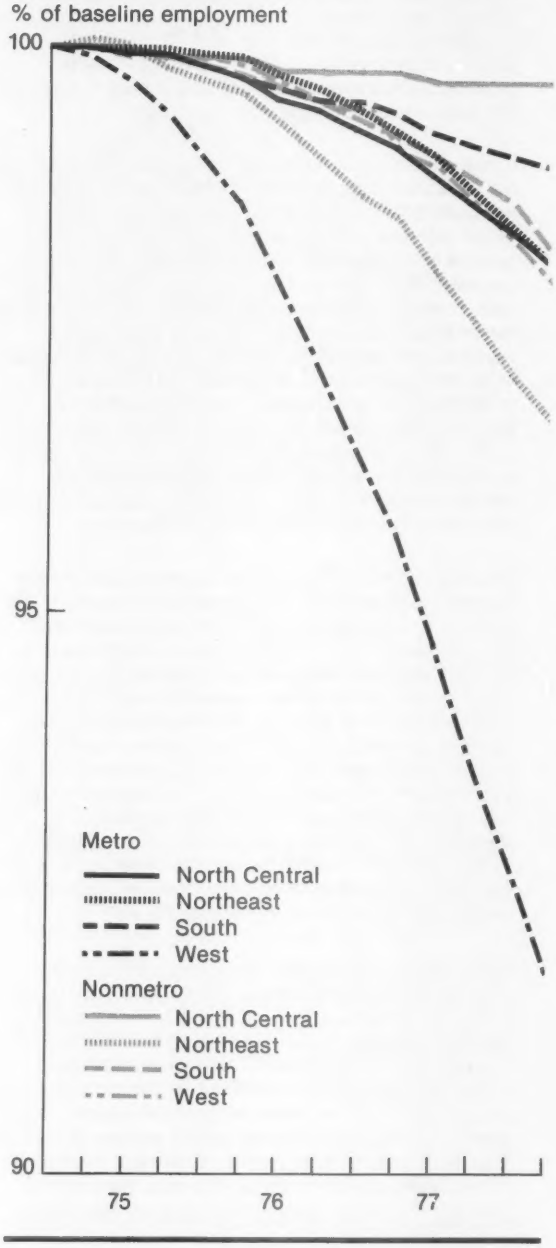


Figure 5

Total Employment by Region, Permanent Tightening of Monetary Policy



at its baseline values. Third, the increased credit to nonmetro regions is financed by bond sales to holders of demand deposits in metro regions, and the sales are distributed according to the relative size of the region's metro demand deposits. Each of the four metro areas incurs the same percentage decrease in demand deposits in 1974:4 to offset the increase in nonmetro deposits. These assumptions imply for the sake of analytic simplicity something not true in practice—that national credit is inelastic so that nonmetro increases are exactly offset by metro decreases. In practice, of course, nonmetro credit might be increased without an offsetting decrease in metro credit.

Effects of this experiment across the four Census regions depend on the metro-nonmetro mix within the regions. The South and North Central regions gain approximately $1.9 and $1.8 billion of credit, respectively, as these regions had relatively less of their deposits in metro banks. The Northeast and West lose approximately $2.5 and $1.1 billion of credit, respectively, as their metro deposits were relatively large. The overall shift of credit from metro to nonmetro areas is approximately $9.5 billion.

Results of this experiment are presented in table 2 and in figures 6 and 7. National real personal income declines by more than 2 percent (compared with baseline) by 1977:4, resulting from the demand deposit shift. The small increase in personal income in nonmetro regions—about 1 percent above baseline by 1976, but back to zero by 1977:4—is more than offset by the more than 3-percent decline in metro regions.

Total national employment declines in response to the deposit shift, although not quite so much as personal income declined. The relative decline in the loan deposit ratio in nonmetro regions makes these regions more competitive in manufacturing, and manufacturing employment in rural areas consequently grows relative to the baseline. However, metro manufacturing employment declines 5 percent.

Income and employment rise in nonmetro regions in the early quarters of the simulation as intended by the policy. Two additional effects are clear from figures 6 and 7. First, income and employment in metro regions decrease as an immediate result of the policy. Second, early gains in nonmetro regions fade in later quarters. Response of metro regions to a change in monetary policy tends to be more elastic than response in nonmetro regions, and it is more heavily weighted in the national totals. Therefore, the decrease in metro economic activity tends to more than offset the gain in nonmetro activity, thus decreasing national totals. The nonmetro economy is linked to the national economy, and as the level of national economic activity declines over time, it pulls the nonmetro regions down with it.

The metro West had the greatest decreases in income and employment while the nonmetro North Central region maintained the greatest long-term advantage, according to table 2. The nonmetro North Central region experienced a sustained rise in income throughout the simulation whereas income in the other three nonmetro regions began to recede about 1 year after the policy was initiated. The nonmetro parts of the North Central and Southern regions experienced a sustained rise in employment throughout the simulation whereas employment in the other two nonmetro regions was below the baseline about 2 years after the policy was initiated. For each of the four Census regions, the nonmetro regions were relatively better off than the adjacent metro regions as a result of the policy. But the nonmetro regions all subsequently receded from initial surges in economic activity.

The increase in demand deposits in 1974:4 pulls up nonmetro total deposits by almost 6 percent immediately.

Table 2—Rural loan policy: Simulated levels of six variables, in the fourteenth quarter of the simulation (1977:4)

Economic variable	North Central		Northeast		South		West	
	Metro	Nonmetro	Metro	Nonmetro	Metro	Nonmetro	Metro	Nonmetro
	Percent of baseline							
Real personal income	97.6	104.2	97.7	98.1	96.8	98.0	94.1	96.9
Total employment	98.8	101.5	98.4	99.1	98.1	101.1	94.1	99.0
Manufacturing employment	96.6	97.9	96.4	99.1	96.3	102.1	82.5	98.5
Housing starts	84.8	98.5	81.5	88.4	89.2	92.7	294.9	100.9
Total deposits	96.7	104.4	96.9	99.8	95.6	103.8	90.7	102.0
Commercial loan/ deposit ratio	101.4	92.6	103.7	94.3	102.1	93.7	111.9	93.3

Figure 6

Real Personal Income, by Region, Rural Loan Policy

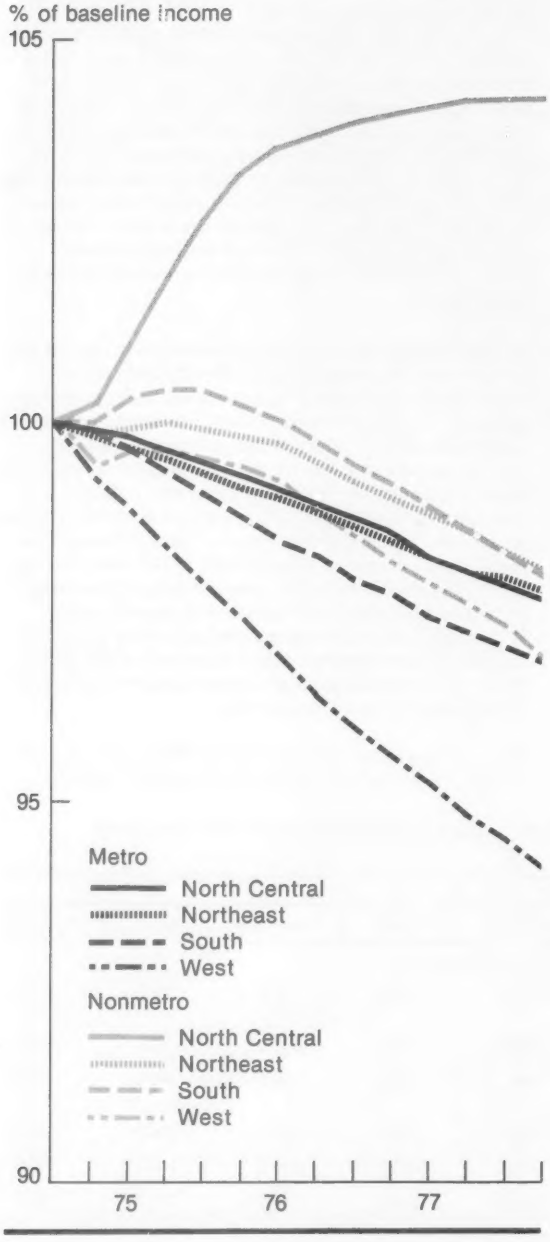
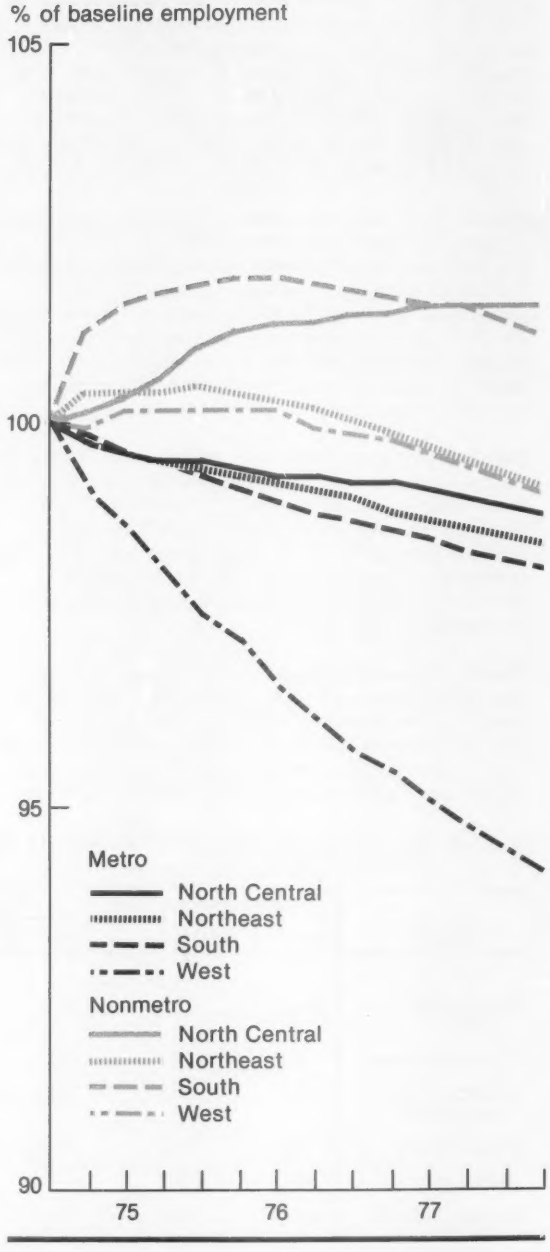


Figure 7

Total Employment by Region, Rural Loan Policy



Similarly, total deposits decline by 1.5 percent in metro regions in 1974:4. Because mortgages are driven by deposits, they shift in a similar fashion. If mortgages flowed without interference across regions, a deposit-mortgage shift should have little effect on the distribution of housing starts. The empirical results of the model indicate regional imperfections in the mortgage market. Rural housing starts slightly increase in 1974:4 and 1975:1 while they sharply decrease in the same periods in metro regions. The decline in nonmetro housing starts by 1977:4 relative to the baseline reflects our finding that nonmetro expansionary effects from the deposit shift are more than offset by metro contractionary effects. Nonmetro credit availability, as indicated by the loan/deposit ratios, remained favorable relative to metro credit availability at the end of the simulation. The decline in nonmetro economic activity from early highs was not caused by a nonmetro credit crunch but, through the linkages of nonmetro regions to metro and national markets, by the metro credit crunch.

Conclusions

An important methodological conclusion of this study is that constructing multiregional models which account for monetary impacts is both feasible and relevant. The model divides the United States into eight geographic regions—four metro and four nonmetro. In addition to its regionalization, the model explicitly introduces a financial as well as a real sector into each region. The regions are linked to each other as well as to national financial and real markets. Financial and real markets are simultaneously determined at the national and regional levels. These features give the model unique capability to analyze how national financial conditions affect economic activity in metro and nonmetro regions.

The empirical results demonstrate responses to changes in national monetary conditions that vary regionally. Urban areas tend to respond more elastically than rural ones. Consequently, during extended periods of tight monetary policy, most induced contraction in income and employment will be in urban places. Some rural areas are relatively isolated from a national credit crunch and can show growth while major urban areas experience a setback.

The findings are important not only for their implications for rural welfare but also because they support the contention that money matters, in the sense that national monetary conditions affect not only financial and price variables but also the real flow of income and employment.

Rural development based on financial credit policies alone can have the intended shortrun effects of increasing rural income and employment. But, the unintended shortrun urban side-effects and their longrun national consequences suggest that it is in the national interest to have rural development programs which depend on other inducements to growth besides credit availability. Rural responses to changing financial conditions are more inelastic than urban responses. Differences in elasticity reflect structural differences in the operating characteristics of smaller, rural banks compared with larger, urban ones. Hence, if $1 of additional rural access to funds is exactly offset by a $1 decrease in urban access, the induced rural growth will likely be more than offset by the urban decline. The consequent decline of the aggregate level of business activity affects both rural and urban prospects. A slack in the national real aggregates accelerates the urban decline, and it can also induce unintended subsequent losses in economic activity large enough to offset intended initial rural gains.

Bioeconomic Analysis of Pesticide Demand

By L. Joe Moffitt and Richard L. Farnsworth*

Abstract

The ability of insects to develop resistance to specific pesticides affects pesticide demand. However, the affect of resistance on demand cannot be observed or measured. This analysis substitutes an expression for the unobserved resistance variable in a pesticide demand model and then illustrates the model's potential by estimating demand for DDT. To arrive at the expression characterizing the unobserved resistance variable, a biological resistance model is constructed, then incorporated into the dosage-response curve. Resistance development is hypothesized to be directly dependent on cumulative pesticide use.

Keywords

Pest resistance, econometrics, pesticide demand

An efficient and economical crop protection system is essential to agricultural production. For the past three decades, the primary pest control tactic used by agricultural producers has been to apply toxic chemicals. However, people have become more concerned over possible adverse effects of pesticide use on the environment, wildlife resources, and human health. Their concern has led to research that investigates each chemical's properties, especially with respect to cancer and mutations, identifies optimal timing and application rates, restricts or bans hazardous products, assesses impacts on gene pools of affected organisms, and investigates declining pesticide effectiveness from pest resistance.

The potential of econometric demand analysis to assess grower behavior and, thus, to increase our understanding of pesticide use appears promising as the observed quantity demanded of a pesticide reflects both economic and technical factors. Understanding the decline in effectiveness of the pesticide arsenal is vital from a resource management standpoint. An important characteristic of biological populations is their ability, by evolutionary adaptation, to develop resistance. An econometric analysis of pesticide use can help us understand resistance development.

A recent bibliographical review of pest control economics literature (*11*) cites several studies (1, 8) which indicate the significance of resistance in pesticide use decisions but cites only one econometric demand study (*3*) which incorporates resistance.[1] Carlson's method (*3*) involves specifying a log-linear demand function which, in addition to the standard explanatory variables such as own price and price of a substitute, includes an index of pest resistance. Carlson developed this pest resistance index from treatment figures contained in various published research reports and noted the potentially crude approximation of an index computed in this manner. Considering the current lack of data on resistance and the meager prospects of future availability of such data, we must consider alternatives methods of estimating pesticide demand. The approach described here involves specifying a resistance development structure that permits an econometric assessment of the impact of pesticide use on resistance development. Parameters in the explanatory equation can be estimated by nonlinear least squares.

Objectives of this research are threefold: (1) to present an explicit mathematical formula for resistance development consistent with models used by biologists and economists,

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[1]Italicized numbers in parentheses refer to items in the references at the end of this article.

(2) to incorporate the expression for resistance, in place of an unobservable resistance variable, in a pesticide demand model, and (3) to illustrate the model's potential by estimating the demand for the insecticide DDT.

Tolerances to different pesticide dose levels are assumed to follow a Weibull density function. The extent to which the killing efficiency of pesticides decreases as resistance increases is defined in the function. The dosage-response or kill efficiency function is the cumulative distribution function of the Weibull density. Borrowing from biologists' S-shaped resistance development models, we hypothesize that resistance development can be modeled using the S-shaped logistic function and that the most important factor affecting resistance development is directly related to cumulative pesticide use. We then substitute the resistance development model into the pest tolerance, or Weibull density, function to provide a mechanism for measuring changing pest tolerances as resistance develops over time. Because resistance is unobservable, the expression characterizing resistance as a function of cumulative pesticide use is substituted into the demand equation. We then estimate a demand function for DDT; the results illustrate the applicability of the resistance model. Finally, we show the limitations of this study and suggest a direction for further research.

Tolerance Density, Dosage Response, and a Characterization of Resistance

Talpaz and Borosh depicted pest tolerances to pesticides using the Weibull density function. The Weibull density of tolerances indicates the proportion of the pest population that is susceptible to pesticide dosage level I but that is not susceptible to any lesser dosage. (For example, some pests, through genetic factors, possess a detoxifying enzyme which provides immunity.)

The Weibull density is:

$$w(I|a,\lambda = \quad a\lambda(aI)^{\lambda-1}\exp[-(aI)^{\lambda}], \text{ if } I\geq 0 \qquad (1)$$

where I is pesticide dose measured in pounds per acre, and a and λ are parameters which determine the shape of the density function. For example, if $\lambda > 1$, the Weibull density function is unimodal and exhibits other usual characteristics of probability density functions.

The dosage-response or kill efficiency function relates cumulative pest mortality to differing pesticide dosages. Available evidence, beginning with Finney's, suggests that the dosage-response relationship increases monotonically and is sigmoidal shaped beginning at the origin and asymptotically approaching 1 as pesticide levels increase. Thus, pest mortality increases first at an increasing, and then at a decreasing, rate as pesticide dosage levels increase.

Given a Weibull density of tolerances, equation (1), the dosage-response function (proportion of the cumulative pest population susceptible to dosage level I) may be defined as the Weibull distribution function, which is constructed by integrating the Weibull density function:

$$W(I|a,\lambda) = \int_0^I w(x|a,\lambda)dx$$

$$W(I|a,\lambda) = \quad 1-\exp[-(aI)^{\lambda}] \qquad (2)$$

if $I \geq 0$. Because λ is restricted to be greater than 1, W (•) satisfies the desirable properties attributed to dosage-response curves:

$$W(0) = 0$$

$$\lim_{I\to\infty} W(I) = 1$$

$$\partial W/\partial I = a\lambda(aI)^{\lambda-1}\exp[-(aI)^{\lambda}] > 0$$

$$\partial^2 W/\partial I^2 > 0 \text{ for } 0 \leq I < ((\lambda-1)/a\lambda)^{1/\lambda}$$

$$\partial^2 W/\partial I^2 < 0 \text{ for } I > ((\lambda-1)/a\lambda)^{1/\lambda}$$

Resistance in a pest population reduces pesticide effectiveness by altering the tolerance density. One can characterize the resistance by defining it as a function of the parameters of the Weibull density. A convenient definition of a resistance parameter that leads to a plausible transformation of the tolerance density and dosage-response function is $\rho = 1/a$.

The corresponding tolerance density and dosage-response functions become:

$$w(I|\rho,\lambda) = \lambda\rho^{-1}(I/\rho)^{\lambda-1}\exp[-(I/\rho)^{\lambda}] \qquad (3)$$

$$W(I|\rho,\lambda) = 1-\exp[-(I/\rho)^{\lambda}] \qquad (4)$$

The conditional mean and variance of the redefined Weibull tolerance density are:

$$E[I|\rho] = \rho\Gamma(\lambda^{-1}+1)$$

$$V[I|\rho] = \rho^2\Gamma(2\lambda^{-1}+1) - (\Gamma(\lambda^{-1}+1))^2$$

respectively, where $\Gamma(\bullet)$ denotes the gamma distribution.

Derivatives of the mean and variance with respect to ρ are:

$$\partial E[I|\rho]/\partial\rho = \Gamma(\lambda^{-1}+1) > 0$$

$$\partial V[I|\rho]/\partial\rho = 2\rho[\Gamma(2\lambda^{-1}+1) - (\Gamma(\lambda^{-1}+1))^2] > 0$$

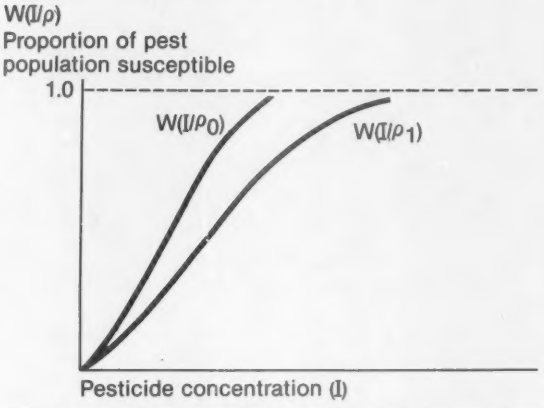
Hence, increasing the resistance parameter shifts the tolerance density to the right and increases the density's dispersion (variance). An increase in resistance alters the dosage-response curve and decreases pesticide effectiveness:

$$\partial W(I|\rho)/\partial\rho = -\lambda\rho^{-(\lambda+1)} I^{\lambda} \exp[-(\rho^{-1}I)^{\lambda}] \leq 0$$

For example, an increase in ρ from ρ_0 to ρ_1 pivots the dosage-response curve to the right and reduces pest mortality at each dosage level (fig. 1).

Figure 1

Dosage-Response Curve



Note: The dosage-response curve is a sigmoidal function which ranges from 0 to 1. It shifts to the right as the resistance parameter ρ increases from ρ_0 to ρ_1, which indicates that as a pest population develops resistance, more pesticides are required to obtain a specific kill level.

Mechanism and Development of Resistance

We have defined resistance as a function of parameters of the tolerance density and have delineated the ramifications of increasing resistance on pesticide efficacy. Now we discuss and model resistance development in a pest population exposed to toxic chemicals. The procedure describes resistance as a function of lagged pesticide applications. The resistance development model is then substituted into the kill efficiency function in equation (4).

Development of resistance in an insect population is a well-known and logical evolutionary process that allows organisms to evolve and adapt to sudden changes in climate and habitat (2, 5). The rate at which resistance develops in a population is influenced by many factors: genetic makeup of the organism; intensity of the selection pressure inducing resistance (for example, pesticide dosage and number of applications); ecological conditions; behavioral mechanisms which prevent fatal exposure; and biology of the organism, including reproductive rate, inbreeding, dispersal, migration, size, and growth rate. Because of their protective mechanisms or other physical factors, some organisms will survive the initial selection pressure. The next generation will contain a higher percentage of resistant organisms. If selection pressure is applied again, resistant organisms will survive and the next generation will have an even larger percentage of pesticide-resistant organisms. Continuous selection pressure eventually results in a population composed largely of resistant organisms.

Entomologists have conducted experiments under controlled laboratory conditions to determine implications of resistance development for pesticide dose levels. Conclusions are generally stated in terms of the lethal dose (LD) required to kill 50 percent of the pest population over g generations. Laboratory results of resistance experiments suggest pesticide dosages necessary to achieve a fixed kill will increase according to a tilted S-shaped pattern over g generations, as figure 2 shows.

Available information can be incorporated into the analysis by using the following logistic specification:

$$I_k = \tau_k/(1+\exp[\phi + \delta_t(\bar{g}(t-1))] \qquad (5)$$

where:

- k = proportion of the pest population killed;
- I_k = pesticide dose required tokill proportion k of the population;
- τ_k = a parameter which represents the maximum insecticide dose necessary to kill proportion k of the pest population as generations tend to infinity;
- ϕ = a parameter that helps identify the insecticide dose necessary to kill proportion k of the pest population, given the initial level of resistance before pesticides are applied;
- δ_t = measure of selection pressure at time t that will be associated with accumulated pesticide applications since time t = 0; and

$\bar{g}$ = number of pest generations per time period.

This logistic representation is consistent with figure 2, providing both the appropriate shape and a positive vertical axis intercept. Note that equation (5) indicates the dosage level necessary to achieve a constant mortality level as resistance develops. δ_t represents the accumulated buildup of resistance, reflecting genetic selection pressure of successive generations. To make this concept operational, we define it as a function of accumulated applications of pesticides. We assume δ_t can be specified as a distributed lag of pesticide levels applied to previous pest generations:

$$\delta_t = \sum_{i=1}^{t-1} \sigma_i I_i / (\bar{g} \bullet (t-1))$$

where σ_i represents an appropriate lag structure. In our subsequent empirical illustration, σ_i is assumed constant ($\sigma_i = \sigma$), which implies:

$$\delta_t = \sigma \sum_{i=1}^{t-1} I_i / (\bar{g} \bullet (t-1))$$

When δ_t is substituted into equation (5), the number of pest generations, g, and time periods drop out. The definition of I_k simplifies to:

$$I_k = \tau_k / (1 + \exp[\phi + \sigma Z_t]) \text{, where } Z_t = \sum_{i=1}^{t-1} I_i \qquad (6)$$

Equation (6) possesses the desired tilted S-shape and describes resistance as a function of cumulative insecticide use. Furthermore, note that figure 2 is a special case of equation (6), when dose is held constant over generations. The vertical axis intercept and horizontal asymptote are:

$$\lim_{t \to o} I_k = \tau_k / (1 + \exp[\phi])$$

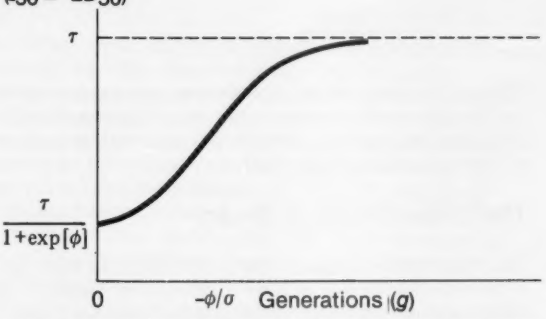
and:

$$\lim_{t \to \infty} I_k = \tau_k$$

The positive vertical axis intercept permits initial resistance in the pest population and is consistent with the dosage-response curve, which is undefined at a zero level of resistance (ρ=0).

Figure 2

Development of Resistance



Note: Biologists hypothesize one of the effects of increasing resistance is to decrease pesticide effectiveness. As resistance develops over *g* pest generations, the lethal dose (LD) necessary to kill 50 percent of the population in every generation increases and follows a sigmoidal growth curve. Mathematically, the logistic function in equation (5) has similar characterisics and can be used to represent the sigmoidal curve.

Our next task is to relate I_k to the resistance parameter ρ in equations (3) and (4). From equation (4), the specific proportion $W_k(\bullet)$ of the pest population susceptible to insecticide dose I is a function of λ and ρ_t. At time t=0, the insecticide dose necessary to achieve $W_k(\bullet)$ is the vertical axis intercept, $\tau_k/(1 + \exp[\phi])$, of the resistance development model:

$$W_k = 1 - \exp[(-\tau_k / \rho_0 (1 + \exp[\phi]))^{\lambda}]$$

Solving for τ_k yields:

$$\tau_k = -(1 + \exp[\phi]) \rho_0 [1n(1 - W_k)]^{1/\lambda}$$

Substituting τ_k into equation (6) yields a resistance development model that is consistent with the dosage-response curve for any time period:

$$I_k = -(1 + \exp[\phi]) \rho_0 [1n(1 - W_k)]^{1/\lambda} / (1 + \exp[\phi + \sigma Z_t]) \qquad (7)$$

Solving equation (7) for W_k yields:

$$W_k = 1 - \exp\left[\frac{-(1 + \exp[\phi + \sigma Z_t]) I_k}{(1 + \exp[\phi]) \rho_0}\right]^{\lambda} \qquad (8)$$

Comparison with equation (4) indicates resistance for any time period can be determined from the following equation:

$$\rho_t = \frac{(1+\exp[\phi])\rho_0}{1+\exp[\phi+\sigma Z_t]} \quad (9)$$

Thus, equation (9) relates resistance to parameters which can be estimated from observable data. Equation (9) will be used to incorporate pesticide resistance into an analysis of demand by farmers for DDT.

Pesticide Demand Model

The importance of equation (9) is that it allows resistance to be included in a pesticide demand equation. Borrowing from Carlson's research, we assume the following Cobb-Douglas demand model:

$$I = A\rho^{\beta} \prod_{i=1}^{k} X_i^{\alpha_i} + U$$

where I is quantity of pesticide demanded; the X_i's are relevant demand variables; ρ is the resistance parameter which characterizes pesticide effectiveness; A, β, and the α_i's are unknown parameters; and U is a stochastic disturbance with mean zero and finite variance. The resistance parameter, ρ, is generally unobservable; hence, the pesticide demand model is not directly estimable. However, equation (9) can be substituted for the unobserved ρ which yields:

$$I = A\left[\frac{(1+\exp[\phi])\rho_0}{1+\exp[\phi+\sigma Z]}\right]^{\beta} \prod X_i^{\alpha_i} + U \quad (10)$$

Several coefficients of equation (10) excluding A and ρ_0 may be consistently estimated by nonlinear ordinary least squares. Results provide demand elasticities as well as an estimate of the inflection point $Z^* = -\phi/\sigma$. All parameters contained in equations (3) through (9) can be estimated if minimal extraneous information—that is, an estimate of the dosage-response function for any period—is available.

DDT Example

To illustrate the theoretical model, we estimated a demand function for DDT and drew implications. DDT was chosen because data were available over a long period. Some compromises and assumptions with respect to variable definitions had to be made to account for aggregate data and structural changes in the agricultural community over time. For DDT, the model is:

$$I_t = B(1/(1+\exp[\phi+\sigma Z_t]))^{\beta}(P_{It}/P_{Rt})^{\alpha}(P_{St}/P_{Rt})^{\alpha} + U_t$$

where:

- I_t = DDT quantity demand (pounds per acre), = $0.5Q_t/A_t$, where $0.5Q_t$ = DDT domestic disappearance (1,000 pounds) and A_t = cotton acres harvested (1,000 acres);
- $B = A((1+\exp[\phi])\rho_0)^{\beta}$ (a constant);
- P_{It} = DDT wholesale price per pound (in dollars);
- P_{St} = Parathion wholesale price per pound (in dollars);
- P_{Rt} = Cotton season-average price per pound received by farmers (in dollars);
- Z_t = Measure of selection pressure in previous generations, $= \sum_{i=1}^{t-1} I_i$ •

All data employed are contained in *Agricultural Statistics* and *The Pesticide Review* for the 1950–70 period. The demand variable, DDT, is expressed in pounds per acre of cotton to account for substantial acreage shifts which have occurred over time. We have deflated the price of DDT and the price of a substitute insecticide, parathion, by an index of prices received by farmers to incorporate an aspect of derived demand.

Finally, selection pressure at time t is defined as cumulative per acre pounds of DDT during the previous t-1 years. A subroutine called & Dogleg in the TROLL/1 software package was employed for nonlinear estimation. The estimated model is:

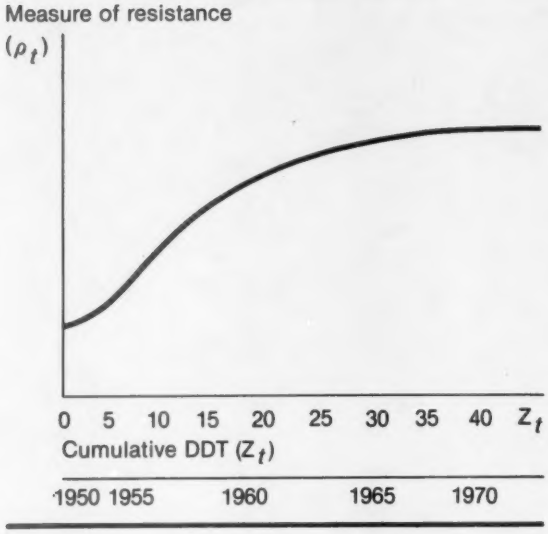
$$I_t = \underset{(0.401)}{0.9577}(1/(1+\exp[\underset{(1359.870)(141.175)}{29.3510 - 3.0544Z_t}]))^{\underset{(1.703)}{0.0366}}$$

$$(P_{It}/P_{Rt})^{\underset{(0.351)}{-0.3306}} (P_{St}/P_{Rt})^{\underset{(0.341)}{0.6077}}, \quad R^2 = 0.54. \quad (11)$$

Asymptotic standard errors are reported in parentheses. Note the estimated coefficients in equation (11), for which *a priori* expectations exist, have the expected sign and are of plausible magnitude. That is, the price elasticity of DDT (P_{It}/P_{Rt}) is negative, and the price elasticity of the substitute chemical, parathion, (P_{St}/P_{Rt}), is positive. The resistance elasticity is 0.0366 and suggests that, during the sample period, additional DDT was applied to compensate for its declining effectiveness. This implies DDT use contributed to real or perceived positive side and cross resistance impacts for other pesticides during much of the sample period. As with the previous study by Carlson, a high degree of statistical significance cannot be attached

Figure 3

Resistance Development for DDT, 1950-70



to many of the individual parameter estimates. This may be attributed to the highly aggregative nature of the data and the relatively low number of degrees of freedom. This phenomenon is likely to occur until more reliable data become available.

Analysis of the resistance coefficients, ϕ and σ, yields another interesting conclusion. Figure 3 represents resistance development over time for DDT using the estimates from equation (11). Complete specification is possible given an estimated dosage-response curve for one of the major pests of cotton during any year of the sample period. The inflection point ($Z^* = -\phi/\sigma$) of this curve equals 9.61. This approximately corresponds to the years 1956–57 and coincides with reports of DDT-resistant boll weevils in cotton during the late fifties (*9*). Furthermore, figure 3 suggests that the effectiveness of DDT had been substantially depleted by the early sixties and that the upper bound on the resistance parameter, τ, was essentially reached by 1970. Despite its declining effectiveness, average per acre applications of DDT remained relatively stable after the inflection point, Z^*, as indicated by the length of the 5-year intervals. The horizontal axis of figure 3 measures accumulated dosages of DDT; the time scale indicates the years in which accumulated dosages were realized.

Based on our results, it seems plausible that careful resistance management (derived from information in fig.3) and the extraneous estimates of DDT effectiveness might have prolonged the viability of DDT in insect control and delayed the need to introduce other more environmentally hazardous substitutes. This hypothesis might be more clearly indicated if the estimated form of equation (11) were substituted into an optimization framework similar to that suggested by Hueth and Regev.

Conclusion

Sound economic analysis of behavioral relationships in the agricultural sector requires researchers to include relevant economic, institutional, and biological variables. All too frequently, some of the important variables are unmeasurable or data are simply not available. Demand models for pesticides are an important case in point. Researchers know pest resistance to different toxic chemicals significantly reduces pesticide effectiveness, which in turn, should affect pesticide demand. Pest resistance data are not available and are, therefore, generally not included in pesticide demand models. The procedure used here replaced the unmeasurable resistance variable in the demand model with a measurable variable based on accumulated applications of pesticides. We estimated the demand function for DDT to illustrate the practicality of the model.

Several important conclusions can be drawn. First, parameters important for resistance management are available as a byproduct of demand analysis and can be estimated without extensive data requirements. Second, given the logistic specification for resistance development, resistance management can be important during the early stages of resistance development. Third, if growers respond to increasing resistance by applying additional pesticides, as they did in the case of DDT, pesticide cancellation will not result in significant additional cost in terms of present patterns of resistance management. Fourth, the model can be generalized to alter our current specification of selection pressure or to add additional variables believed to influence resistance development. Finally, resistance development has many similarities with diffusion literature (6, 7, 10, 12). Further analysis may help us understand resistance development and pesticide demand and also promote sounder policy decisions in this heavily regulated and environmentally important sector.

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In Earlier Issues

Sampling is particularly fruitful in agricultural statistics. . . . [An] important reason . . . is the reduction of heavy workloads in the Government agencies that conduct surveys. [There have been] efforts to convert one-time censuses and large-scale current enumerations to a sample-survey basis.

Heinrich Strecker
Vol. 7, No. 1, Jan. 1955, p. 12

Research Review

Accounting for Commodity Credit Corporation Loans in Farm Income

By Roger Strickland*

Commodity Credit Corporation (CCC) loan programs have been an important marketing tool for U.S. farmers for several decades. Prior to 1980, CCC loans were accounted for in the U.S. Department of Agriculture's (USDA) farm income estimates by adding the value of new loans made to open-market sales at the farm gate. Old loans repaid were subtracted in order to avoid double-counting when the commodity was subsequently marketed.

This procedure has been questioned on the grounds that, if CCC loans are indeed loans and not sales, they should be treated like other loans and distinguished from open market sales receipts. The alternative to including CCC loan payments as receipts when received is to account for only those loans which the farmers never repay, referred to as loans forfeited or liquidated. The value of loans forfeited or liquidated would be added to open market sales when the loan is terminated and the Government takes ownership of the commodity.

Beginning with the farm income statistics published in 1980, USDA will estimate two alternative cash receipt series: (1) the old series which includes the net value of CCC loans made and repaid and (2) a new series which includes only the value of CCC loans forfeited or liquidated. All production must be accounted for as marketed, either directly or via livestock, or added to inventory stocks. Thus, a change in quantity marketed due to a change in the treatment of CCC loans will have an offsetting effect on quantity in inventory. If net farm income is defined to include the value of inventory change, then the treatment of CCC loans will not substantially affect net farm income. It can, however, have a significant effect on realized net income, defined to exclude the value of inventory change.

In using cash receipt estimates, one may have to choose between the two series. The choice will be a definitional one and could depend on one's assumptions and type of analysis. I will consider some key issues in characterizing CCC loans and in defining receipts as income. The issue is important because the old series may be discontinued after the new one is established.

A review of the terms and payments under the CCC loans program indicates that, although a CCC loan does possess some attributes of other types of loans (bank, PCA, and others), the loan has several key attributes of a sale. In fact, a case can be made that a CCC loan is a sale to CCC or to the Government for a price that is at or above market price with an option, for a fee labeled as interest, to purchase an equal quantity at a later date, if it becomes advantageous to the producer.

CCC loans possess the following nonloan features:

1. The decision as to whether to "repay the loan" or "forfeit the collateral" and finalize the sale is solely at the discretion of the payee.

2. If the farmer decides it is not desirable to pay the "interest" cost associated with the agreement, the loan is not repaid nor is it revoked, but the option of reclaiming the commodity is lost.

3. The collateral specifies a quantity and grade of the commodity held in reserve. It does not specify a particular bushel of grain in the way that an automobile loan specifies a particular automobile. So, the right to repay the CCC loan and reclaim a quantity of the commodity is really an option to buy a certain quantity at a given price. Under a true production loan from a bank or PCA that is secured by the commodity, the farmer would be expected to repay the loan and dispose of the collateral. The farmer would bear all risk of a drop in the commodity price. Under a CCC loan, the farmer bears no downside risk and reclaims the commodity only if the current market price exceeds the loan or "call" price.

The Internal Revenue Service (IRS) allows the farmer the option of reporting the funds received either by forfeiting or delivering the commodity or by reclaiming and selling the commodity. In cases where payments from CCC are reported when received but the option to reclaim and market the grain is exercised, only that portion of the sale value above the amount originally reported is taxable income reportable in the year of sale. Once a farmer selects one of the two options, permission to change must be requested from IRS. This requirement tends to discourage frequent year-to-year switches.

The test that IRS usually applies to determine when a payment becomes reportable income is the point at which the payee has control over the money to do with as he or she

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pleases. Thus, one can have reportable income before receiving money, that is, because payment is delayed due to an action or decision of the payee. One can have earned income, but it is not reportable income because the money is not yet available. For example, profit from the sale of common stock is not reportable until the settlement date, which is a week after the sale date. The seller knows on the day of sale how much profit was made but cannot get access to the funds until settlement date.

Since IRS allows the payee an option as to when payments may be reported, this flexibility could be construed as evidence that it considers CCC payments to be income. IRS does not normally give taxpayers the opportunity to select the timing of payments so as to minimize their taxes; on the contrary, IRS has definite rules for determining when income is reportable. In the case of CCC loans, it may not be politically feasible for IRS to rule that the payments were not loans, when the Congress has specifically labeled these payments as loans.

The option granted by IRS gives the farmer two alternative income tax strategies from which to choose. The CCC payments may be reported at the time the commodity is sold instead of when the loan disbursement is received. By continually rolling over a series of loans, the farmer can postpone reporting the sale of the crop placed under the program indefinitely or until participation in the program, at least temporarily, is ended. That may well occur during a year of high prices in which the storage bins are emptied.

Alternatively, the farmer can opt to report the payments as income as the loans are received. Under a progressive tax structure, taxes can be minimized by smoothing the taxable income reported. Postponing the reporting of receipts from CCC until the contract is terminated may result in reporting income from the sale of several years' production in a single year and in a year of high market prices.

Thus, the CCC commodity loans have attributes similar to those of other loan types, for example, repayment, interest, and collateral, but the disposition of the proceeds of CCC loans is solely at the discretion of the payee. The payee may opt not to pay the money back to CCC. The option to pay back would be chosen only if the grain could be sold for profit. In such a case, the farmer's additional income received in the current year would be the difference between the amount of the repayment to CCC and the receipts from selling the commodity on the open market.

Which is the "best" definition of farm income is not clear. There are arguments for and against each side. In the short run, both series are available, and the user of the statistical series has a choice. The discussion above may help users make that choice.

In Earlier Issues

The role that law plays in the conservation of renewable natural resources is often overlooked by agricultural economists. [There are] grave doubts on the wisdom . . . of placing sole reliance on the classical economic doctrine that owners pursuing their own best interests assure full utilization, development, and conservation.

Erling D. Solberg
Vol. 6, No. 4, Oct. 1954, p. 129

Computer Modelling in Agriculture

N. R. Brockington. Oxford, Eng.: Oxford University Press, 1979. $26.00, 156 pp.

Reviewed by Linda Calvin*

The author intended this book as an introduction to computer modeling for agriculturalists, particularly those concentrating on the biology of production. The type of modeling discussed is variously described as computer modeling, dynamic system modeling, and dynamic simulation modeling. These are certainly very general categories; a more specific description would be system dynamics modeling. Despite the vague title, it is a good introduction which will also serve agricultural economists well.

Most literature on system dynamics falls into two groups: theoretical discussions on modeling, which are often very mathematical and give the reader little idea of what a program actually looks like or how to build one, and manuals which describe a particular programming language in detail but provide no perspective on how system dynamics differs from other modeling techniques. This book provides a useful, easy-to-read introduction which combines theory and practice. It is an important book for a limited audience: people with no experience in system dynamics modeling who want both a brief overview of where this technique fits into the general configuration of modeling techniques and an introduction to the mechanics of building a system dynamics model.

Those readers who want only an idea of what their modeling colleagues are doing will find this book a sufficient introduction. Others who would like to do modeling themselves will have to do additional reading, but Brockington's text is an excellent starting point, particularly for those people who are easily intimidated by math, new programming languages, and esoteric theoretical discussions. System dynamics modeling requires a sound understanding of the complex interactions between components of the system to be modeled and a basic understanding of a fairly simple modeling technique. This book demystifies the methodology and will enable many people to pursue modeling activities.

Brockington introduces the concept of a system and describes the different types of models used in agriculture. Although the sophisticated modeler may disagree with the schematic classification of models presented, the beginning modeler will find the discussion illuminating; it clarifies the concepts of system dynamics by comparing it to econometric and linear programming models. Brockington also discusses the stages of model building: (1) development of a verbal description of the system, (2) design of a pictorial representation (flow diagram) which shows the structure of the system, and (3) construction of a quantitative computer model of the system. Stages 1 and 2 are discussed in chapter 2 which presents fundamentals of flow diagramming as developed by Forrester (*1*)[1]. The author describes and diagrams problems of continuous biological growth, carbon metabolism in plants, and animal population growth. Additional problems are provided at the end of the chapter with answers at the end of the book.

Brockington uses these same problems to construct computer programs—the next step. He describes the relative virtues of the two types of computer languages available for system dynamics modeling: general purposes languages, such as FORTRAN and ALGOL, and specialized languages, such as CSMP and DYNAMO. The general languages are flexible and and can be used for any type of problem, but they require additional programming to make a model dynamic. Specialized simulation languages are oriented towards the standard operations that occur frequently in system dynamics, but they may be awkward in some situations. The dynamic elements are built into the specialized languages.

Each program is written in both FORTRAN and CSMP, and sample computer printouts are presented. The FORTRAN used in these examples is not very sophisticated; the most complex element is the "do loop" procedure. Anyone who understands FORTRAN should be able to follow CSMP with no trouble. Although CSMP is not a common lanaguage, it is similar to DYNAMO, which is much more common. In a 1977 survey of simulation models by S.R. Johnson and Gordon Rausser (*2*), 85 percent of the models were written in FORTRAN or ALGOL. The most common specialized language was DYNAMO which was used in 8 percent of the cases; none of the studies used CSMP. Comparing the FORTRAN and CSMP sample programs is extremely helpful to the person who can choose what language to use. Brockington concludes that the choice of language depends on the type of model the researcher wants and that person's current knowledge of computer languages. The specialized languages do not take as long to learn as the general languages, an advantage to the beginner. Brockington

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[1]Italicized numbers in parentheses refer to items in the reference section at the end of this review.

seems to believe that the specialized languages may be inefficient in their use of computer time; my experience indicates that DYNAMO is a rather inexpensive language. He also discusses choice of a time variable, incorporation of nonlinear equations, and stochastic variables. Problems at the end of the chapter introduce sensitivity testing.

Chapter 4 presents more complex concepts and techniques; perhaps too complex, given the level of the previous material. Unfortunately, the examples are only in CSMP. If, after reading the first three chapters, a researcher is inspired to do some modeling, I think it is best to skim chapter 4, choose a language, and then pursue these more complex concepts in the appropriate language manuals. Brockington elaborates on flow rates—constant and variable rates, feedbacks, exponential delays, pipeline delays, and multiple factor rate controls—and discusses transport processes.

Brockington briefly discusses programming techniques in GPSS for event-oriented (discrete) models. The final chapter describes procedures for testing the models.

This book does exactly what the author set out to do: provide an "entree" for those who are interested in modeling agricultural systems. It presents standard material in a simple and effective manner.

References

(1) Forrester, J. W. *Industrial Dynamics.* Cambridge, Mass.: M.I.T. Press, 1961.

(2) Judge, George G., Richard H. Day, S.R. Johnson, Gordon C. Rausser, and Lee Martin (eds.). "Quantitative Methods in Agricultural Economics, 1940s to 1970s, *A Survey of Agricultural Economics Literature.* Vol. 2. Minneapolis: Univ. of Minnesota Press, 1977.

In Earlier Issues

An important cause [of increased expenditures for marketing services] is that consumers want certain services with their food. Here the separation of the services supplying time, place, and form utility from the raw commodity raised on the farm becomes academic. To the housewife, they are part and parcel of the can of frozen orange juice she buys.

Marguerite C. Burk
Vo. 6., No. 1, Jan. 1954, p. 19

Rural Change: The Challenge for Agricultural Economists

Glenn Johnson and Allen Maunder, eds. Oxford, Eng.: International Association of Agricultural Economics, Institute of Agricultural Economics, 1981. $38.50, 738 pp.

Reviewed by Joseph W. Willett*

Rural change was the theme of the 17th International Conference of Agricultural Economists held in Banff, Alberta, Canada, in September 1979. In his presidential address, Denis K. Britton noted that the first meeting was held 50 years earlier and he asked, "What could we in the agricultural economics profession today show to our founders by way of achievement?"

To demonstrate the contributions to the "progressive value of knowledge" by the profession over the years, Britton referred to the *Survey of Agricultural Economic Literature* which was published under the auspices of the American Agricultural Economics Association. Britton also identified other scholarly reviews of the profession's output. "Despite all this testimony," said Britton, "the task which the present generation inherits is undiminished." He then cited some dubious evidence about rural poverty from which he concluded that agricultural economists have shown a "notable lack of success" in promoting "the economical provision of the material requirements of the good life for rural people." He maintained that "the underlying concern, rightly or wrongly, is with equity and not with productivity" and cited as his authority President Nyerere of Tanzania. Britton concluded that while being concerned with the many large problems of "our shipwrecked humanity," economists "should appreciate the value of . . . marginal increments of improvement at the points of greatest opportunity and greatest need. . . ."

W. A. Lewis, who was subsequently awarded the Nobel Prize for Economics, presented the Elmhirst Memorial Lecture—"Development Strategy in a Limping World Economy." Lewis concluded that, whereas past economic growth in the less developed countries (LDC's) was driven by trade, this factor will be less important in the immediate future because of the economic problems of the more developed countries. In his judgment, "some of the LDC's have already reached the stage of self-sustaining growth;" these latter will "make it" in any case. But, ". . . the rest still need a background of world prosperity if they are themselves to prosper."

In addition to the addresses by Britton and Lewis and a "synoptic" address by President-Elect Theodor Dams, 51 other papers with discussions were presented. This reviewer agrees completely with Dams' statement that "to compile an overview of the wide range of contributions is a difficult task." Dams judged that the Banff Conference demonstrated a special concern with overspecialization and was committed to offering specialists the opportunity to share broadening views. Dams referred to the conferees' interest in problems of food "gaps," difficulties of small farmers and the landless, economic planning issues, needs for food security, and investment needs in LDC's. He emphasized that poverty presents an ethical-moral challenge to agricultural economists, and he thought that the conferees had shown a great willingness to accept the responsibility.

Because marketing efficiency affects rural incomes, Dams drew attention to the papers on marketing. He said that the research has many gaps and that much more work is needed to integrate small farmers and the poor into the markets. He thought that the strategy of relying on rapid industrialization to automatically solve these problems has failed.

Dams pointed out that numerous conference papers using quantitative methods had drawn much criticism during the discussions. He emphasized the importance of economists' applying quantitative tools to real-world problems rather than placing undue concern on merely polishing their tools.

Dams also emphasized the importance of studies on decisionmaking and planning procedures in agriculture, a subject which had been the principal topic at the International Association of Agricultural Economists conference in Nairobi 3 years earlier. The Banff Conference included a first-hand paper on agriculture in the Peoples Republic of China and papers on agricultural planning in Eastern Europe, as well as papers and discussions on decisionmaking in multinational firms, parastatal organizations, and state trading agencies. Dams warned that in spite of some progress, the methods of agricultural economists continue to be more appropriate to analysis of and recommendations for large, rather than small, farms.

Several conference papers showed that outmigration from agriculture and structural changes within agriculture still generate major social frictions, even in developed countries. Agricultural surpluses and related problems continue in many countries. The relationship between central and local planning agencies in developing countries, conflicts between localities over rural development programs, and research on farming systems received much attention.

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Although conference members discussed energy analyses of agriculture and the difference between the approaches of economists and ecologists, Dams thought these problems needed more research and should be discussed at the 1982 Conference. He said that international cooperation, international agencies, and integration will present even greater challenges to agricultural economists in the future because of the increasing interdependence of national economies. The papers and discussions also raised questions about whether LDC students of agricultural economics in the United States and Europe receive adequate training that will help them solve their countries' economic problems. Concerning the relationships between politics and research and the concomitant challenge to the professional integrity of agricultural economists who are consulted by governments, Dams suggested they should make clear whether they are working in positive or normative economics.

Dams found the Banff Conference to be much concerned with the need for interdisciplinary research—which he pointed out—had been an issue throughout the Association's 50-year history. He suggested that economists might foster interdisciplinary work by first examining specific problems, formulating objectives, and then raising questions for members of other disciplines.

Dams also referred to complaints at the Banff Conference by economists from developing nations about the difficulties in communicating their research results and in gaining access to important studies undertaken in their own countries either by other governments or by international institutions. He suggested that more serious efforts should be made to exchange and discuss research; however, he thought some of those problems could be solved informally rather than at the institutional level. Dams concluded by suggesting as "survival principles"—tolerance, amiable disagreement, and group thinking.

The conference program, organized by Vice President Glenn Johnson, grouped the papers into eight sections: the role of agricultural economics in micro, subnational, national, supra-national, multi-nation, parastatal, and state trading agencies, and within the discipline. The contributed papers were published in 1981 in the IAAE's Occasional Papers series (*The Rival Challenge*, Gower Publishing Co., Aldershot, Eng.). Reports of the meetings of 32 discusion groups and photographs of most of the participants appeared in IAAE Members' Bulletin No. 3, published in March 1981.

Dams referred to the "Conference sandwich" and Britton wished a *bon appetit* to the conferees in attacking the "feast of intellectual food" supervised by Glenn Johnson. This reviewer agrees that there is much sound nutrition as well as palatable fare in this volume, but there is some junk food as well. Nonetheless, all agricultural and development economists should at least sample the fare.

American Journal of Agricultural Economics

Edited by James P. Houck, University of Minnesota

Published by the American Agricultural Economics Association

November 1981

Articles: Runge, "Common Property Externalities in Traditional Grazing"; Connor, "Food Product Proliferation"; Boggess & Heady, "Alternative Income Support and Soil Conservation Policies"; Penson, Romain, & Hughes, "Investment in Farm Tractors"; English, Short, & Heady, "Crop Residues as Auxiliary Fuel"; Schmitz, Firch, & Hillman, "Export Dumping and Mexican Winter Vegetables"; Rosegrant & Herdt, "Credit Policy and Fertilizer Subsidy in the Philippines"; Daubert & Young, "Recreation Demand for Instream Flows"; Miller & Hay, "Hunter Participation for Ducks"; and Norton & Davis, "Evaluating Returns to Agricultural Research." Notes: Ospina & Shumway, "Slaughter Beef Composition and Prices"; Lang & Rosa, "Price Variation in Direct and Terminal Markets"; Reed & Riggins, "Disaggregated Corn Acreage Response." Plus more Notes, Comments, and Book Reviews.

Annual membership dues (including Journal) $25; annual subscription rate $35; individual copies $10. Contact Sydney C. James, Department of Economics, Iowa State University, Ames, Iowa 50011. Published in February, May, August, November, and December.

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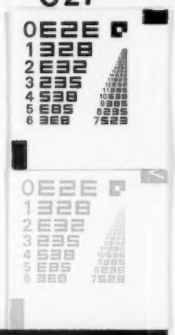
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